

# **TOPIC 09 – REDOX**

## **9.2 – REDOX EQUATIONS**

IB Chemistry  
T09D01



## 9.2 – Redox Equations

- 9.2.1 Deduce simple oxidation and reduction half-equations given the species involved in a redox reaction. (3)
- 9.2.2 Deduce redox equations using half equations. (3)
- 9.2.3 Define the terms oxidizing agent and reducing agent. (1)
- 9.2.4 Identify the oxidizing and reducing agents in redox equations. (2)



## 9.2

# Redox Half-Equations:

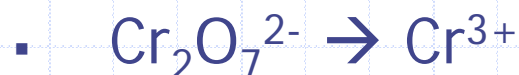
9.2.1 Deduce simple oxidation and reduction half-equations given the species involved in a redox reaction. (3)

- Many redox reactions are only brought about under certain conditions.
- As discussed in Topic 10, an acidified aqueous solution can often provide these conditions
- The half equations frequently include  $\text{H}_2\text{O}$  and  $\text{H}^+$  ions
- Similar procedures can be followed for the construction of half-equations for
  - Oxidation Reactions
  - Reduction Reactions



# For Oxidation Reactions

1. Write down the formulae of the reactant and products:



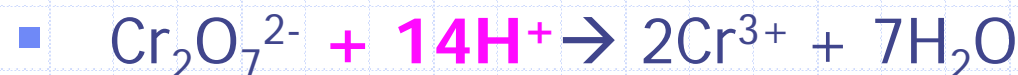
2. Balance with respect to the chromium:



3. Balance the O atoms of the dichromate (VI) with  $\text{H}_2\text{O}$



4. Balance the H atoms in water with  $\text{H}^+$  ions



5. Determine total charge of each side



6. Balance two charges by adding electrons



# For Reduction Reactions

1. Write down the formulae of the reactant and products:



2. Balance with respect to the nitrogen:



3. Balance the O atoms of the dichromate (VI) with  $\text{H}_2\text{O}$



4. Balance the H atoms in water with  $\text{H}^+$  ions



5. Determine total charge of each side



6. Balance two charges by adding electrons



# Redox Equations:

## 9.2.2 Deduce redox equations using half equations. (3)

- If given both the reduction and oxidation half equations, you should be able to balance and simplify the equations
- A common example is the oxidation of a primary or secondary alcohol (via dichromate or manganate)



# If given both the half-equations

- Following Topic 10 again, if the half-equations for the oxidation of methanol (and reduction of manganate)



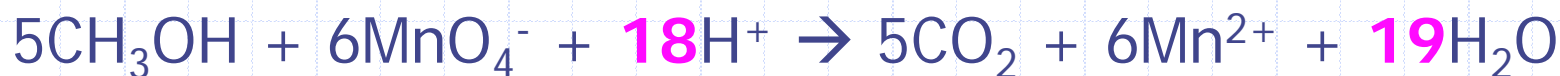
- Equalize the number of electrons** lost and gained



- Add the two** half-equations together



- Cancel electrons** and simplify numbers of  $\text{H}_2\text{O}$  and  $\text{H}^+$



# Agents

## 9.2.3 Define the terms oxidizing agent and reducing agent. (1)

- An **oxidizing agent** is defined as a substance that brings about the oxidation of substances by accepting electrons from the substance they oxidize
  - Oxidizing agents undergo **reduction**
- A **reducing agent** is defined as a substance that brings about the reduction of a substance by donating electrons to the substance it reduces.
  - Reducing agents undergo **oxidation**





# Identify Agents

## 9.2.4 Identify the oxidizing and reducing agents in redox equations. (2)

- Common **reducing agents** (things that are **oxidized**)
  - **Hydrogen:**  $\text{O}^{2-} + \text{H}_2 \rightarrow \text{H}_2\text{O} + 2\text{e}^-$ 
    - $\text{PbO} + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{Pb}$
  - **Carbon:**  $\text{O}^{2-} + \text{C} \rightarrow \text{CO} + 2\text{e}^-$ 
    - $\text{PbO} + \text{C} \rightarrow \text{Pb} + \text{CO}$
  - **Carbon Monoxide:**  $\text{O}^{2-} + \text{CO} \rightarrow \text{CO}_2 + 2\text{e}^-$ 
    - $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
  - **Metals:**  $\text{Cu}^{2+} + \text{Zn} \rightarrow \text{Zn}^{2+} + \text{Cu}$ 
    - $\text{CuSO}_4 + \text{Zn} \rightarrow \text{ZnSO}_4 + \text{Cu}$



# Oxidizing Agents

## Common **oxidizing agents** (things that are **reduced**)

- Oxygen:  $\frac{1}{2} \text{O}_2 + 2\text{e}^- \rightarrow \text{O}^{2-}$
- Ozone:  $\text{O}_3 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{O}_2 + \text{H}_2\text{O}$ 
  - $2\text{KI} + \text{O}_3 + \text{H}_2\text{O} \rightarrow 2\text{KOH} + \text{O}_2 + \text{I}_2$
- Chlorine:  $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
- Acidified  $\text{KMnO}_4$ :  $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$
- Acidified  $\text{K}_2\text{Cr}_2\text{O}_7$ :  $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
- Acidified  $\text{H}_2\text{O}_2$ :  $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}$
- Metal ions:  $\text{Ag}^+ + 1\text{e}^- \rightarrow \text{Ag}$
- Hydrogen ions:  $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ 
  - $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
- $\text{MnO}_2$ :  $\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Mn}^{2+} + 2\text{H}_2\text{O}$



# Balancing via Redox Method

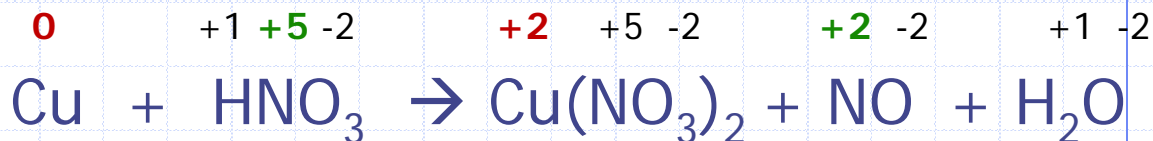
- Often, chemical equations are difficult to balance based due to large and uneven numbers of reacting and produced species.
- A systematic approach using the principles of redox may allow you to balance such equations:



## 9.2

## Balancing Redox Equations 1

1. Assign oxidation numbers to the species in the reaction
2. Find the substance oxidized and the substance reduced
3. Write half reactions for the oxidation and reduction
4. Balance the atoms that change in the half reaction
5. Determine the electrons transferred and balance the electrons between the half reactions
6. Combine the half reactions and balance the remaining atoms
7. Check your work. Make sure that both the atoms and charges balance

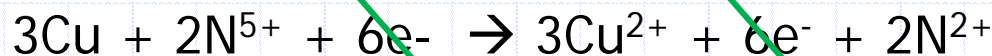


Copper Oxidized, some Nitrogen Reduced

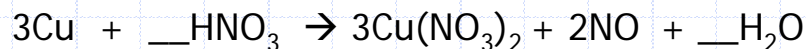


\*both are balanced

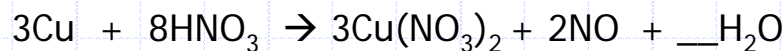
2 e- ox, 3 e- red, lowest common multiple = 6 e-



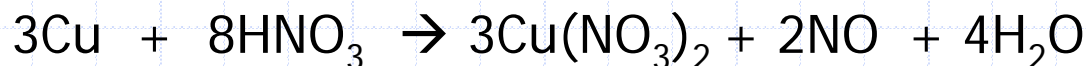
\*Ratio of Cu compounds to NO (5+) must be 3:2



\*Next balance out the nitrogen (total)



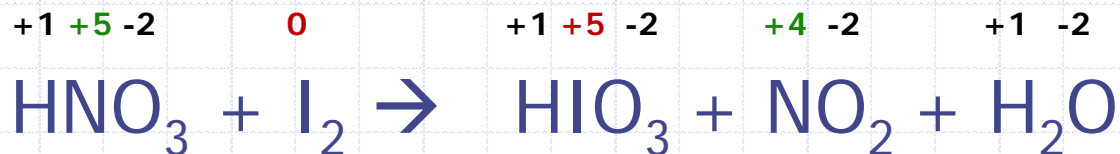
Balance the final product



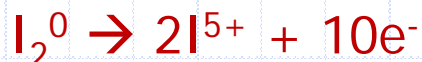
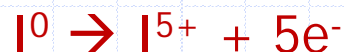
## 9.2

## Balancing Redox Equations 2

1. Assign oxidation numbers to the species in the reaction
2. Find the substance oxidized and the substance reduced
3. Write half reactions for the oxidation and reduction
4. Balance the atoms that change in the half reaction
5. Determine the electrons transferred and balance the electrons between the half reactions
6. Combine the half reactions and balance the remaining atoms
7. Check your work. Make sure that both the atoms and charges balance

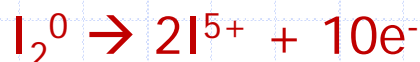


Iodine Oxidized, some Nitrogen Reduced



\*both are balanced

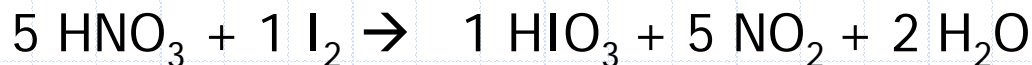
10 e- ox, 1 e- red, lowest common multiple = 10e



\*Ratio of N compounds to I must be 5:1



Next balance out the water, you're done



# Redox Titrations

